Methods for Phosphorus Control Plan & Nutrient Source Identification Report Development

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Introduction

This document details the Massachusetts Department of Conservation and Recreation's methodology for the development of Phosphorus Control Plans and Nutrient Source Identification Reports which were developed to meet the requirements of EPA's National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit.

The 2016 National Pollutant Discharge Elimination System General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s) in Massachusetts ("the MS4 Permit") includes requirements for MS4s that discharge to nutrient-impaired waters with total maximum daily loads (TMDLs; Appendix F) and without TMDLs (Appendix H). Specifically, MS4s that discharge to select waterbodies with phosphorus TMDLs such as the Charles River and several lakes and ponds, are required to prepare Phosphorus Control Plans (PCPs). In addition, MS4s that discharge to in-state phosphorus or nitrogen impaired waterbodies without TMDLs or out-of-state waterbodies with nitrogen or phosphorus TMDLs are required to prepare Phosphorus or Nitrogen Source Identification Reports, collectively referred to here as Nutrient Source Identification Reports (NSIRs).

PCP required:

- Charles River
- Select lakes and ponds with phosphorus TMDLs

NSIR required:

- In-state waterbodies impaired for Nitrogen (N) or Phosphorus (P) without TMDLs
- Out-of-state waterbodies with N and P TMDLs

The Massachusetts Department of Conservation and Recreation (DCR) owns properties across Massachusetts that discharge stormwater directly or indirectly to the Charles River, to the select lakes and ponds with phosphorus TMDLs, and to other nutrient-impaired waterbodies. As such, to comply with the MS4 Permit, DCR must develop several PCPs and NSIRs.

This document details DCR's methodology for PCP and NSIR development and is supplemental to DCR's PCP and NSIR reports. Data sources and analysis are similar for PCPs and NSIRs, which is why

methodology for both types of reports are presented in one common document. This document discusses permit interpretation, data sources, and analysis, whereas watershed-specific data and results are included within the water body specific PCPs and NSIRs.

This document includes the following chapters:

- **Chapter 2.** Scoping – Discusses the methods used to determine the geographical scope of DCR's PCPs and NSIRs.
- **Chapter 3.** Analysis – Discusses the approaches used to perform the catchment delineation and load and target analysis for regulated DCR facilities within watersheds of waterbodies requiring PCPs and NSIRs.
- **Chapter 4.** Planning – Discusses the approaches used to identify and credit best management practices (BMPs).
- **Chapter 5.** Reporting – Discusses the structure of PCP and NSIR reports.

2

Scoping

This chapter discusses the methods used to determine the implementation area of the PCPs and NSIRs.

For the purposes of this approach document, scoping the PCP and NSIR includes identifying the implementation area for the respective plans. The implementation area is defined as the DCR MS4 regulated area that discharges to a waterbody requiring a PCP or NSIR. This section first discusses the determination of watershed areas used to identify DCR facilities that may discharge to a waterbody requiring a PCP or NSIR. The section then describes the methods to determine if facilities within those watersheds are generating regulated discharges.

Further calculations to identify PCP baseline loads and targets are discussed in the next chapter.

2.1 Watershed Evaluation

In order to determine which DCR facilities should potentially be included in a PCP or NSIR, we first needed to identify the watersheds of the waterbody segments requiring PCPs and NSIRs. While MassDEP does have GIS layers with water body segments and their impairments (based on the MassDEP 303(d) list), they do not currently provide a shapefile with the corresponding watersheds of the segments. Therefore, we created a watershed boundary layer using the methodology discussed below.

2.1.1 Determination of Relevant Waterbodies

PCPs: Appendix F of the MS4 permit indicates that PCPs are required for the Charles River and a select list of lakes and ponds (Table F-6 of Appendix F). Since Table F-6 does not provide specific MassDEP Integrated List of Waters (Integrated List) Waterbody IDs, VHB used the 2016 Integrated List to identify the appropriate segments for the Charles River and the Lakes and Ponds TMDLs.[1]

1 MassDEP. Massachusetts Year 2016 Integrated List of Waters: Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. December 2019. https://www.mass.gov/doc/final-massachusetts-year-2016-integrated-list-of-waters/download

Error! Reference source not found. lists the waterbody names and their respective Integrated List Waterbody ID. Since DCR only has MS4 regulated property within some of the watersheds, the table below only shows the waterbodies for which DCR is required to develop a PCP. Grouped waterbodies are within the same watershed.

Table 1 MS4 Permit Appendix F PCP-Requiring Waterbodies for DCR and Corresponding Integrated List Waterbody IDs

Waterbody Name	Assessment Unit ID
Charles River	MA72-01
	MA72-03
	MA72-04
	MA72-05
	MA72-06
	MA72-07
	MA72-33
	MA72-36
	MA72-38
Lake Quinsigamond	MA51125
Flint Pond	MA51188
Leesville Pond	MA51087
Auburn Pond	MA51004
Bents Pond	MA35007
Ramsdell Pond	MA35062

NSIRs: Waterbodies requiring NSIRs are covered in Section B.I. and B.II of the MS4 permit's Appendix F (out of state nitrogen and phosphorus TMDL waters) and Section I and II of the MS4 permit's Appendix H (in-state nitrogen and phosphorus impaired waters without TMDLs). The list of segments which are covered by each NSIR is listed within the respective DCR NSIR documents.

The out-of-state nutrient TMDL waterbodies include the Long Island Sound with a nitrogen TMDL and eight Rhode Island waterbodies with phosphorus TMDLs which are listed with their Rhode Island Integrated List Waterbody ID in Appendix F Table F-12:

- Upper Ten Mile River
- Lower Ten Mile River
- Central Pond
- Omega Pond
- Turner Reservoir
- Upper Kickemuit River
- Kickemuit River
- Kickemuit Reservoir

In-state nutrient and phosphorus impaired waters without TMDLs were identified by reviewing the Final 2016 Integrated List of Waters (303(d) list) for waterbodies which had impairments listed as "total nitrogen" or "total phosphorus" and did not include other "nutrient-related" impairments, based on clarification in EPA's MS4 permit's Response to Comments #204 and #1099.[2] These waterbodies are shown in the DCR NSIR & PSIR Web Application.[3]

Note that in February 2022, the 2018/2020 303(d) list was finalized.[4] Appendix H Sections I.2 and II.2 state the following for nitrogen and phosphorus impaired waters, indicating that the requirement deadlines discussed in this document for Permit Years 4 and 5 will not be required for newly listed waterbodies until 4 and 5 years after the Stormwater Management Plan (SWMP) includes these newly listed waterbodies.

> "Upon EPA or MassDEP notification that the permittee is discharging to a waterbody that is water quality limited due to nitrogen, the permittee shall update their SWMP within 90 days to incorporate the requirements of Appendix H part I.1 and document the date of SWMP update. When notification occurs beyond the effective date of the permit, deadlines in Appendix H part I.1 shall be extended based on the date of the required SWMP update rather than the permit effective date."

2.1.2 Defining Watersheds

To define watershed boundaries for the waterbody segments that require PCPs or NSIRs, we were required to consider discharges to the waterbody itself "or its tributaries" as cited in the MS4 Permit Section 2.2.1. EPA clarified in Response to Comment #209 that all upstream tributaries are included within the NSIR scope because "discharges of nutrients in stormwater not only affect the point at which the discharge enters the receiving waterbody, but also affect downstream waterbodies." In addition, PCP requirements apply to permittee MS4 discharges "that discharge to the identified impaired waters or their tributaries" according to the MS4 Permit Appendix F.

2.1.2.1 Watershed Boundary Delineations

There is no current publicly available watershed layer that provides watershed boundaries which match the Integrated List waterbody segment boundaries for Massachusetts. Therefore, DCR developed geospatial watershed boundaries for all PCP and NISR-requiring waterbody segments in order to identify DCR facilities discharging to these waterbodies.

Delineations were based on the following data sources for the initial delineation and then adjusted based on desktop review, as necessary, to align with the Integrated List segments. Data sources are listed below in the order in which they were considered. The U.S. Geological Service Data Series 451 provides HUC12 identifiers as well as subbasins. Subbasins were delineated on a finer scale than

2 EPA Response to Comments on: National Pollutant Discharge Elimination System (NPDES) General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts, April 2016 https://www3.epa.gov/region1/npdes/stormwater/ma/2016fpd/rtc-2016-ma-sms4-gp.pdf

3 https://vhb.maps.arcgis.com/apps/dashboards/4cfdc963fe0442aba6e91c69c05064ac#mode=view

4 MassDEP. "Final 2018/2020 Integrated List of Waters." February 2, 2022. https://www.mass.gov/lists/integrated-lists-of-waters-related-reports

HUC12 boundaries. This dataset was used as the basis of watershed delineation while additional sources were utilized to further refine watershed boundaries for impaired waters.

- USGS Data Series 451[5]
- USGS NHDPlus Dataset[6]
- USGS Watershed Boundary Dataset[7]
- USGS StreamStats[8]
- MassDEP Division of Watershed Management[9]
- MassDEP Massachusetts Estuary Project[10]

For watersheds of waterbodies with TMDLs, delineated watershed boundaries were cross-checked with figures presented within the respective TMDL reports.

2.1.2.2 Nested Watersheds

As mentioned, the watersheds of the waterbodies requiring PCPs and NSIRs include all upstream tributaries. Due to the nature of the stream networks and the impairments of lakes and streams, there are many cases where segments which are hydraulically connected each require PCPs and/or NSIRs. In this case, the downstream segment's PCP or NSIR would already need to include the upstream segment, since these reports are required for the waterbody of concern and its tributaries. Therefore, we developed a system that took these nested watersheds into account.

To simplify the evaluation of areas that need multiple PCPs and/or NSIRs, we identified the watershed of the most downstream applicable segment as the "parent" segment and identified all segments within that cumulative watershed as "child" watersheds of that parent. In this way we could work with the parent watershed polygons to avoid double counting overlapping areas or use the child watersheds to perform analysis for each individual segment when needed.

PCP and NSIR parent and child watersheds are shown with the respective report deliverables.

5 USGS. "Local and Cumulative Impervious Cover of Massachusetts Stream Basins." Data Series 451. (2009). https://pubs.er.usgs.gov/publication/ds451

6 USGS. "NHDPlus High Resolution." https://www.usgs.gov/national-hydrography/nhdplus-high-resolution

7 USGS, USDA, & NRCS. "Federal Standards and Procedures for the National Watershed Boundary Dataset (WBD) (4 ed.): Techniques and Methods. 11-A3." (2013). https://pubs.er.usgs.gov/publication/tm11A34

8 USGS. "StreamStats: Streamflow Statistics and Spatial Analysis Tools for Water-Resources Applications." (v. 4) https://www.usgs.gov/publications/streamstats-version-4

9 MassDEP & MassGIS. "MassDEP 2016 Integrated List of Waters (305(b)/303(d))." Commonwealth of Massachusetts. (December 2020). https://www.mass.gov/info-details/massgis-data-massdep-2016-integrated-list-of-waters-305b303d

10 MassDEP. "The Massachusetts Estuaries Project and Reports." Commonwealth of Massachusetts. https://www.mass.gov/guides/the-massachusetts-estuaries-project-and-reports

2.2 DCR Regulated Facilities

2.2.1 Facilities Layer Development

In 2019 DCR developed a geospatial data layer that contains facilities currently owned or maintained by DCR. The purpose of this layer is to provide DCR with a spatial representation of these facilities, along with associated information about the facilities, to help with planning, inspections, and other MS4 permit requirements. This layer was compiled using a variety of sources from multiple institutions. A list of these sources is shown below:

- Protected and Recreational Open Space[11]
- Statewide parcel data, excluding Boston[12]
- Boston parcel data[13]
- MassDOT roads[14]
- Newly acquired DCR properties (provided by DCR)
- Snow parkways (provided by DCR)

This facility layer and the boundaries were not field surveyed or confirmed with property deeds. This layer is dynamic and is updated as new information is obtained or as property transfers are made.

2.2.2 Determining Facility Regulation Status

Although DCR owns property throughout the Commonwealth, only some is considered regulated by the MS4 permit. As part of MS4 compliance and planning, DCR determined which areas met the MS4 regulated definition. A facility or portion of facility was deemed not regulated if it met any of the following criteria:

- Is not within an urbanized area
- Does not discharge stormwater from a point source (i.e., no channelized flow of stormwater to a waterbody)
- Discharges to combined sewers covered by a separate NPDES permit

Non-regulated facilities were excluded from further analysis for the PCPs and NSIRs.

A desktop review of each DCR facility within a PCP or NSIR watershed was conducted to determine the facility's MS4 regulation status. Since a DCR facility may include many distinct parcels, for this task a DCR facility was defined as a DCR property that shares a common name and/or operational

11 MassGIS. "Protected and Recreational OpenSpace." Commonwealth of Massachusetts. (2019). https://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace

12 MassGIS. "Property Tax Records." Commonwealth of Massachusetts. (Nov. 2018) https://www.mass.gov/info-details/massgis-data-property-tax-parcels

13 Boston Maps. "Boston Parcels 2018." Analyze Boston. (Jan. 2019). https://data.boston.gov/dataset/boston-parcels-20182

14 MassDOT Office of Transportation Planning & MassGIS. "Massachusetts Department of Transportation (MassDOT) Roads." Commonwealth of Massachusetts. (Jan. 2019). https://www.mass.gov/info-details/massgis-data-massachusetts-department-of-transportation-massdot-roads

purpose. Examples include Blue Hills State Park and Storrow Drive. Under the evaluation, an entire facility or a portion of a facility was deemed regulated or not regulated.

2.2.2.1 Urbanized Area Review

DCR facilities' MS4 regulated status was first reviewed by assessing whether a facility was in an urbanized area. This analysis was performed using spatial coverages of the urbanized area and DCR facility boundaries. Spatial coverage of urbanized area was determined using a combination of both 2000 and 2010 Urbanized Areas as defined by the U.S. Census Bureau.[15,16] Facilities that were determined to be outside the urbanized area were tagged as "not regulated" within the DCR facilities layer.

2.2.2.2 Point Source Discharge Review

EPA's MS4 permit covers regulated "discharges" from "point sources" as defined in the permit's Appendix A:

> Discharge of a pollutant - any addition of any "pollutant" or combination of pollutants to "waters of the United States" from any "point source," or any addition of any pollutant or combination of pollutants to the waters of the "contiguous zone" or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation. This includes additions of pollutants into waters of the United States from surface runoff which is collected or channeled by man; or discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.
>
> Point source - any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff.

Based on these definitions and the MS4 permit Response to Comments (#944 and #953), runoff that is not channelized and conveyed to a waterbody is not regulated as a point source discharge.

To determine if facilities generated point source discharges, urbanized portions of facilities were inspected in a desktop setting to determine if elements of an MS4 (e.g. pipes, drainage swales, catch basins, BMPs) or other elements that concentrate flow were present. The following datasets were used within ArcGIS to make these determinations:

- DCR drainage infrastructure
- MassGIS 3-meter topographic data[17]

15 U.S. Census Bureau. "Urbanized Area and Urban Cluster Central Places for Census 2000." Revised October 8, 2021. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2000-urbanized-areas.html

16 U.S. Census Bureau. "2010 Census Urban and Rural Classification and Urban Area Criteria." Revised October 8, 2021. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html

17 MassGIS. "Elevation Contours (1:5,000)." Commonwealth of Massachusetts. (June 2003). https://www.mass.gov/info-details/massgis-data-elevation-contours-15000

- MassGIS 1-meter impervious cover data[18]
- MassGIS 15-cm aerial imagery[19]
- Google Street View imagery[20]

Facilities without point source discharges were tagged as "not regulated" within the DCR facilities layer.

18 MassGIS. "Impervious Surfaces 2005." Commonwealth of Massachusetts. (February 2007). https://www.mass.gov/info-details/massgis-data-impervious-surface-2005

19 MassGIS. "2019 Aerial Imagery." Commonwealth of Massachusetts. (Spring 2019). https://www.mass.gov/info-details/massgis-data-2019-aerial-imagery

20 Google. "Streetview." Digital images. Google Maps. https://www.google.com/maps

3

Catchment Delineation, Land Cover Analysis, Pollutant Loading, and Reduction Target Calculations

This chapter discusses the approaches used to further analyze regulated DCR facilities within watersheds of waterbodies requiring PCP and NSIRs to delineate catchments, analyze land cover, calculate pollutant loading, and calculate pollutant reduction targets for PCPs.

The MS4 permit Appendix F requires that permittees determine baseline phosphorus loading and treatment targets for permittee property in PCP watersheds. Appendix H of the permit requires the determination of total MS4 discharging areas, delineation of catchments, and identification of catchments with higher nutrient sources and catchment impervious and directly connected impervious area (DCIA) for each NSIR receiving water segment.

To address these permit requirements for both PCP and NSIR areas, we delineated catchments and performed land cover analysis and loading calculations for those catchments. For PCP watersheds we used those values to further develop pollutant reduction targets. The following sections describe these approaches.

3.1 Catchment Delineations and Treatment Status Categories

MS4 regulated facilities were subdivided to create catchments based on their gross drainage patterns (e.g. to which impaired water segment they discharge) and their potential for treatment. This approach creates catchments suited to identify pollutant loading hot-spots and prioritizing areas for future treatment. Note that these methods created catchments that do not necessarily align with the

catchments used for illicit discharge detection and elimination (IDDE) analysis. The IDDE catchments are focused on specific drainage infrastructure networks to identified outfalls, whereas these catchments include areas that are better suited for analyzing and prioritizing pollutant loading and identifying treatment potential.

Each catchment was assigned a treatment status based on whether the catchment was a "non-discharge" or discharging catchment. A catchment was assigned a "non-discharge" designation using the same criteria that was used to determine if an entire facility was not regulated, as described in Section 2.2.2. If a catchment was deemed discharging, the treatment status was assigned based on a cursory assessment of the catchment's potential for implementing stormwater treatment. This cursory review for potential treatment was performed to assist with steps in subsequent PCP and NSIR requirements. Each catchment was assigned one of the following treatment statuses:

- Unregulated: Catchment within a DCR facility that is not regulated. See Section 2.2.2.
- Non-Discharge: Catchment that does not include any channelized discharge and is therefore not considered regulated.
- Discharge to CSO: Catchment discharging to a known combined sewer.
- Existing: Catchment drains to an existing BMP identified in DCR's drainage infrastructure database.
- High Potential: Catchment does not currently drain to a BMP but, after an initial desktop review, it appears there is potential to collect and treat runoff (with focus on impervious cover runoff) with a retrofit BMP sited on DCR property.
- High Potential - Impervious Cover Disconnection: Catchment contains an existing or potential impervious cover (IC) disconnection opportunity based on desktop review. The catchment includes both the impervious area generating runoff and the pervious area receiving runoff. These scenarios, if already existing, could be transferred to a treatment status of "existing" once field verified.
- Low Potential: Catchment does not currently drain to a BMP and after an initial desktop review, the catchment could possibly be treated by a retrofit BMP, but site constraints indicate that BMP construction would likely require significant design and construction effort and/or the catchment is not a significant source of pollutant loading.
- Not Feasible: Catchment that does not appear feasible to retrofit with structural stormwater treatment measures after desktop review. Constraints for these areas were noted within the database. These areas may be revisited with subsequent review.

The following datasets were used within ArcGIS to delineate and evaluate catchments within a desktop setting:

- DCR drainage infrastructure
- MassGIS 3-meter topographic data[21]

21 MassGIS. "Elevation Contours (1:5,000)." Commonwealth of Massachusetts. (June 2003). https://www.mass.gov/info-details/massgis-data-elevation-contours-15000

- MassGIS 1-meter impervious cover data[22]
- MassGIS 15-cm aerial imagery[23]
- Google Street View imagery[24]

3.2 Pollutant Load Estimates

Pollutant loading estimates were generated for each regulated catchment to:

- Determine PCP baseline loads (phosphorus),
- Identify pollutant loading hot spots, and
- Develop catchment prioritization for NSIRs (phosphorus/ nitrogen)

3.2.1 Approach

Error! Reference source not found. summarizes the MS4 permit guidance and DCR's approach for load calculations for the various watersheds.

Table 2 Nutrient Loading Calculation Approach

Watershed Category	Permit Guidance	DCR Approach
Charles River PCP	Use loading totals calculated by EPA presented in Appendix F, Table F-2	Recalculated baseline loads using DCR regulated areas and EPA's methodology, which uses loading rates from Appendix F, Attachment 1, Table 1-2 and estimates of DCIA.
Lake and Ponds PCPs	Use Appendix F, Attachment 1, Table 1-1 composite loading rates based on land use	Used Appendix F, Attachment 1, Table 1-1
NSIRs	Prioritize catchments with high nutrient loading	Calculated catchment loading using Appendix F, Table 1-2 for phosphorus and Appendix F, Attachment 3, Table 3-2 for nitrogen and estimates of DCIA. Used loading estimates to support catchment prioritization.

22 MassGIS. "Impervious Surfaces 2005." Commonwealth of Massachusetts. (February 2007). https://www.mass.gov/info-details/massgis-data-impervious-surface-2005

23 MassGIS. "2019 Aerial Imagery." Commonwealth of Massachusetts. (Spring 2019). https://www.mass.gov/info-details/massgis-data-2019-aerial-imagery

24 Google. "Streetview." Digital images. Google Maps. https://www.google.com/maps

3.2.2 Spatial Datasets

The spatial datasets used for these pollutant loading calculations include:

- MassGIS 1-meter impervious cover data[25]
- MassGIS 0.5-meter land use data (2005)[26]
- USDA NRCS hydrologic soil group[27]
- MassGIS 15-cm aerial imagery[28]
- Google Street View imagery[29]

The impervious cover and land use spatial datasets were cross checked by comparing them to the aerial imagery and adjusting as necessary. For the Charles River Watershed, if discrepancies were identified using aerial imagery, Google Earth historic imagery from 2005 was referenced to evaluate whether the discrepancy was due to changes in land use or impervious cover since 2005. Documentation of layer adjustments were noted within DCR's database.

For all watersheds, the 2005 MassGIS land use data was used in lieu of a more recently released 2016 land use / land cover dataset.[30] Although the 2016 data is more recent, the land use categories included in the 2016 layer do not readily align with the loading categories included in the MS4 permit, and at the time of the calculations, no crosswalk table with the 2016 data was available (compared to the MS4-provided crosswalk in Appendix F, Attachment, Table 1-3). The 2016 data provides both land use and land cover information that creates the need for a much more complex crosswalk to align with the loading rate categories. In addition, DCR properties' land use and cover vary widely and required more detailed vetting for accurate representation within both land use and land cover categories.

3.2.3 Pollutant Loading Calculations

For the Lakes and Ponds PCP catchments, catchment boundaries were intersected with the land use layer, impervious cover layer, and hydrologic soil group (HSG) layer, and then each intersected area was assigned a loading rate, based on methodology outlined in Appendix F Attachment 1. Total loads were then summed at the catchment and watershed levels.

For the Charles River PCP, even though the MS4 permit provides baseline load, DCR recalculated the baseline load so that load was calculated only for DCR areas determined to be regulated (see Sections 2.2 and 3.1 for more information on which areas were considered regulated). Baseline load

25 MassGIS. "Impervious Surfaces 2005." Commonwealth of Massachusetts. (February 2007). https://www.mass.gov/info-details/massgis-data-impervious-surface-2005

26 MassGIS. "Land Use (2005)." Commonwealth of Massachusetts. (June 2009). https://www.mass.gov/info-details/massgis-data-land-use-2005

27 MassGIS. "Soils SSURGO-Certified NRCS." Commonwealth of Massachusetts. (Accessed August 20, 2020). https://www.mass.gov/info-details/massgis-data-soils-ssurgo-certified-nrcs

28 MassGIS. "2019 Aerial Imagery." Commonwealth of Massachusetts. (Spring 2019). https://www.mass.gov/info-details/massgis-data-2019-aerial-imagery

29 Google. "Streetview." Digital images. Google Maps. https://www.google.com/maps

30 MassGIS. "2016 Land Cover/Land Use." Commonwealth of Massachusetts. (May 2019). https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use

was estimated following EPA's methodology outlined in EPA's 2014 MS4 Fact Sheet, Attachment 1.[31] This methodology uses the loading rates from MS4 permit Appendix F, Attachment 1, Table 1-2 and land use crosswalk in Table 1-3, along with an estimate of DCIA based on the Sutherland Equations. The Sutherland Equations empirically estimate DCIA area based on total impervious area and land use, as presented in EPA's 2014 MS4 Fact Sheet, Attachment 1, Table 6. The total impervious area for the Charles River watershed was used in the Sutherland Equations.

For the Charles PCP and NSIR catchments, spatial data layers for land use, impervious cover, and HSG were overlayed with the regulated catchment boundaries to develop polygons with unique values. Impervious areas were further divided between DCIA and areas that are not directly connected and therefore use the pervious loading rate. All areas were then assigned loading rates based on EPA's nitrogen and phosphorus load export rates categories using the land use crosswalk provided in Appendix F, Attachment, Table 1-3. Loads were then summed at the catchment and watershed level.

3.2.4 Charles River Loading Changes Since 2005

The MS4 Permit requires for the Charles River Watershed a Performance Evaluation starting in Permit Year 6 that includes an estimate of the increase in phosphorus load due to development since 2005. This load change is then combined with the baseline load.

Through desktop review, DCR identified areas where impervious cover has changed since 2005 and developed spatial polygons representing either added or removed impervious cover for calculation of resulting loading changes. Those areas along with their respective land use was used along with the Pollutant Load Export Rates (PLERs) presented in Appendix F, Attachment 1, Table 1-2 to estimate the phosphorus load change due to development.

Note: As of Permit Year 4 these values have not been calculated and will be presented in the PY 6 Annual Report as required by the MS4 permit.

3.3 DCIA Estimates for NSIRs

The MS4 permit Appendix H requires the estimation of DCIA within NSIR watersheds. DCR used the Sutherland Equations, which empirically estimate directly connected impervious area based on total impervious area and land use, as presented in 2014 EPA documentation.[32] The "highway" land use was not included in this documentation and was therefore assigned the "Average" Sutherland equation described as "Mostly storm sewered with curb & gutter, no dry wells or infiltration, residential rooftops not directly connected." DCIA was calculated at the catchment level using the total impervious area value of the catchment and the appropriate DCIA equation based on land use.

31 USEPA. Charles River Basin Nutrient (Phosphorus) TMDLs, Phosphorus Load Export Rates and BMP Performance. Attachment 1 – Fact Sheet Massachusetts Small MS4. 2014. https://www3.epa.gov/region1/npdes/stormwater/ma/2014FactSheet-Attachment1.pdf

Note that the assignment of the Sutherland equations to the various land use categories presented in this fact sheet differs from the assignment of the equations to land use categories presented in other EPA documentation. See Section 3.3 for more details on DCIA calculations used for the purposes of the NSIRs.

32 USEPA. Estimating Change in Impervious Area (IA) and Directly Connected Impervious Area (DCIA) for Massachusetts Small MS4 Permit. April 2014. https://www3.epa.gov/region1/npdes/stormwater/ma/MADCIA.pdf

Totals of DCIA were summed at the catchment and then watershed level. These DCIA areas were used in the pollutant loading calculation described in Section 3.2.3.

3.4 Target Calculations for PCPs

Permittees must calculate load reduction targets in the form of mass per year for the Lakes and Ponds PCP areas. In addition, because DCR recalculated baseline loads for the Charles River PCP area, we recalculated load reduction targets for the Charles River watershed from those presented by EPA in Appendix F Table F-2. Impaired waters segments requiring NSIRs do not have numeric treatment targets and therefore do not require target calculations.

3.4.1 Lakes and Ponds

The MS4 permit Appendix F, Table F-6 provides the TMDL phosphorus load reductions for each waterbody as a percentage. Permittees are required to estimate the load reduction as mass based on their calculated baseline load.

The baseline loading values calculated for the Lakes and Ponds PCP areas (see Section 3.2) were used along with the load reduction percentages for each respective lake or pond as presented in Appendix F, Table F-6. Percent reductions were multiplied by the estimated load to generate a load reduction as mass per year.

3.4.2 Charles River

DCR recalculated the Charles River mass load reduction required using the refined baseline loading values calculated for the Charles River PCP areas (see Section 3.2) and the waste load allocation (WLA) reduction percentages for the Charles River as presented in EPA's April 22, 2014 Memorandum recreated as **Error! Reference source not found.**.[33] Load reductions for the Charles River PCP are based on the TMDL percent reductions that vary between the Upper/Middle and the Lower Charles River subbasins and vary by land use. Therefore, DCR tracked loading by land use and subbasin and then assigned percent reductions according to their respective category. To mimic EPA's approach, load reductions were then summed at the entire Charles River watershed level to get an estimate of total load reduction in mass per year. This mass load reduction was then compared to the baseline load estimate to calculate the overall percent reduction.

Table 3 TMDL Waste Load Allocation (WLA) P Load Reduction Rates Applied to Land Use Groups in Upper and Lower Charles River Watersheds

Land Use Group	Upper TMDL WLA % Reduction Rate	Lower TMDL WLA % Reduction Rate
Commercial	65%	62%
Industrial	65%	62%

33 EPA Memorandum to Permit File for Draft Small Massachusetts MS4 General Permit from Mark Voorhees, Office of Ecosystem Protection with Subject "Overview of Methodology to Calculate Baseline Stormwater Phosphorus Loads and Phosphorus Load Reduction Requirements for Charles River Watershed – Draft MA MS4 Permit" – obtained by EPA to present methods used by EPA to calculate TMDL target load reductions.

High Density Residential	65%	62%
Medium Density Residential	65%	62%
Low Density Residential	45%	62%
Highway	65%	62%
Open Space	35%	62%
Agriculture	35%	62%
Forest	0%	0%

3.5 NSIR Catchment Prioritization

Appendix H requires the prioritization of NSIR catchments with higher potential nutrient load. Catchments were prioritized for nutrient load mitigation based on their calculated pollutant loading as described in Section 3.2 (nitrogen or phosphorus depending on the NSIR subject pollutant). In order to equitably prioritize among catchments of different sizes and land uses, we used the metric of nutrient load per unit area to compare catchments. The catchments were then prioritized based on their loading rate.

Prioritization categories were developed by approximating composite loading rates for 10% DCIA (cut off between low and medium priorities) and 50% DCIA (cut off between medium and high priorities) using the Commercial/Industrial and Developed Pervious HSG B land use loading rate categories. We track each catchment's calculated total nutrient load as part of the DCR database, which is used for catchment prioritization and evaluation as potential BMP are identified and evaluated for retrofit potential. Prioritization may change as catchments and potential BMPs are reviewed in more detail in Permit Year 5.

Table 4 NSIR Load Prioritization Categories

Priority	Phosphorus (lbs./acre/year)	Nitrogen (lbs./acre/year)
High	>1.0	>8.1
Medium	0.3 – 1.0	2.6 – 8.1
Low	<0.3	<2.6

4

Planning

This chapter will be further developed as the planning phase of the PCP and NSIR work continues in Permit Year 5.

4.1 BMP Identification and Crediting

4.2 Cost Estimates and Schedule

5

Reporting

This chapter discusses the approach used to generate the PCP and NSIR reporting documents.

Per the MS4 permit, NSIRs are due in Permit Year 4 and PCPs are due in Permit Year 5. In PY 4, Appendix F requires reporting PCP scope and baseline loading and targets. That information is submitted within the PY 4 Annual Report and references approaches included within this document.

5.1 Report Scope

To avoid redundancy, NSIR reports were organized to include all nested nutrient impaired waterbody segments tributary to and including a most downstream parent nutrient impaired water body segment. See Section 2.1.2.2 for more information on nested watersheds. For each system, the most downstream water body segment subject to the NSIR requirements was used as the primary water body identified in the report. Each report is focused to provide DCR and EPA with the most relevant data for the water bodies included in each report and fulfills the relevant MS4 Appendix submission requirements.

Note: As of PY 4 only NSIRs have been developed. As such this section currently focuses on NSIR reporting.

5.2 Report Approach

The overall approach to PCP and NSIR reporting includes the following components:

- PCP reports provide the waterbody specific information and results of the PCP calculations
- NSIR reports provide the waterbody specific information and results of the NSIR calculations
- Approach document (this document) describes the means and methods for the analysis required for the PCPs and NSIRs

- Web maps display custom views of DCR's databases to provide EPA with both spatial and tabular data in lieu of generating multiple static figures and tables.